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Eutrophication Assessment Using Phytodiversity at the Land-Water Interface of Lake Anasagar of Ajmer

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ABSTRACT

Since most of the water, silt, nutrients, and organic inputs from the catchment areas must pass through the land-water interface before reaching the water body, the biota of this zone and the ecosystem processes operating therein play a significant role in regulating water quality, biodiversity and productivity of inland waters. Therefore, this zone can be considered as a biological frame of the aquatic ecosystem. As the effect of pollutants coming from various anthropogenic activities and factors operating on land are more pronounced at the interface, the aquatic flora growing here may be indicative of trophic state of the water body. The present study deals with phytoplankton and macrophytes as a criterion for trophic evaluation of Anasagar- a perennial freshwater lake of Ajmer which is being influenced by a number of anthropogenic activities on its margin. Human settlements and construction activities in the catchment areas lead to deterioration of the water quality of the lake. The study indicates that rather than physico-chemical characteristics used to classify wetlands under oligo- and eutrophic scales, Phytodiversity is a potent criterion for trophic evaluation. As a major element of aquatic biota, the algal community often exhibits dramatic changes in response to different types of pollutants. Hence, the diversity of algal component in the aquatic ecosystem serves as a reliable index for biomonitoring of pollution load. Land-water interface is rich in algal diversity, in all 123 algal species belonging to Cyanophyceae (41), Chlorophyceae (48), Bascillariophyceae (22) and Euglenophyceae (12) were recorded. On the basis of number of algal species belonging to various groups, Nygaard Trophic State Indices were calculated which indicate hypereutrophic status of wetland. Wetland plants in land-water interface play an important role in nutrient dynamics. The contribution of some dominant macrophytes in nutrient enrichment at the land-water interface was also assessed. It was estimated that among the macrophyte species, *Azolla pinnata* and *Trapa bispinosa* contributed maximum to the total nutrient inputs into the lake waters. If these macrophyte species are removed before decomposition Starts, nutrient enrichment of the lake may be checked to a large extent. Recently many initiatives have been taken to restore Lake Anasagar under National Lake Conservation Program through installation of water treatment plant and by providing aeration in the water body. This will favourably affect the biological components including algal flora and macrophytes. Data on the physico-chemical analysis state that the water quality is still not improved because inputs of fertilizers and detergents have not been checked so far.

Key words : *Phytoplankton, Macrophytes, Cyanophyceae, Chlorophyceae, Bascillariophyceae, Euglenophyceae, Nygaard Trophic State Indices*

Introduction

Water bodies situated in arid and semi-arid regions like Rajasthan are highly valued because water is very precious here. They also confer great biological and landscape diversity, providing an interesting framework for ecological research. Unplanned urbanization, rapid industrialization and indiscrimi-

nate use of artificial chemicals in agriculture are causing heavy and varied pollution in aquatic environments leading to deterioration of quality and depletion of aquatic biota (Yeole and Patil, 2005).

The effect of effluent load from various sources and factors operating on land are more pronounced at the land-water interface of the shallow water body. Since most of the water, silt, nutrients and organic inputs from the catchment areas must pass through the land-water interface before reaching the water body, the biota of this zone and the ecosystem processes operating therein play a significant role in regulating water quality, biodiversity and productivity of inland waters (Gopal, 1994). It provides favourable conditions for aquatic vegetation, therefore, macrophytes and algal flora growing here may be indicative of trophic state of a water body. The role of macrophytic vegetation in management of aquatic ecosystem has been well emphasized (see Gopal, 1990). Similarly algal community has been used as an indicator of water quality (Nygaard, 1949; Gunale and Balakrishnan, 1981). Phytoplanktons are an ecologically important group in most aquatic ecosystems but are nevertheless often ignored as appropriate indicators of aquatic ecosystem changes

Therefore, the present study was made to enlist the macrophyte and algal species of Anasagar Lake of Ajmer and to point out their relevance in assessment of trophic state of the water body. Rates of weight loss and nutrient release potentials of dominant macrophytes provide valuable information pertaining to the trophic state and cycles which involve complex interactions between phytoplanktons, macrophytes and nutrients (Melzer, 1981; Wiegleb, 1984). So, keeping this in view, contribution of selected macrophytes in nutrient-enrichment at the land-water interface was also assessed.

Sites of the Study

The Lake Anasagar- a perennial freshwater lake situated in the heart of Ajmer city. This lake is surrounded mainly by housing colonies and human settlements. At least half of the total margin length of this lake is affected by agricultural practices. Thus, the lake is under the multifold pressure of pollutants coming from various anthropogenic activities like urban sewage disposal, cloth washing activities and agricultural practices. Collection of water samples for physico-chemical characteristics and algal and macrophyte surveys were done on entire interface sites of the water body.

Materials and Methods

Water samples were collected in acid washed polyethylene bottles and were analysed for physicochemical characteristics as described in the 'Standard Methods' (APHA-AWWA-WPCF 1998), Algal samples were collected from different interface sites of Anasagar in acid washed plastic tubes and preserved in 5% formalin and identified with the help of standard references (Prescott, 1951; Desicachary, 1956; Randhawa, 1959). Nygaard Trophic State Indices were calculated (Nygaard, 1949; Gunale and Balakrishnan, 1981). List of macrophytes were also prepared from different interface sites. Rate of decomposition of selected dominant floating and submerged macrophytes was estimated by % loss in weight under experimental conditions. For the computation of total nutrient release, biomass of each species was also estimated by quadrat method during the period of occurrence at interface site of Lake Anasagar and mean annual values were estimated.

Results and Discussion

As per the scale proposed by Rawson (1960) for oligo- and eutrophic scales, the study showed that Anasagar lake is a eutrophic lake because some of the characteristics i.e., conductance, dissolved solids, alkalinity, calcium, magnesium, and chlorides were recorded at higher side. Alkaline pH also indicates eutrophic nature of the lake.

Major nutrients like nitrogen and phosphorus also play an important role in the process of eutrophication. These nutrients are added into the lake through various anthropogenic activities and decomposition of vegetation and plankton debris. High concentrations of these nutrients in lake were reported by Sharma (1993). These nutrients promote growth of Cyanophyceae, mainly noxious blooms of *Microcystis aeruginosa* and Actinomycetes which add noxious odour and cause serious threat to aquatic life.

Algae as Indicator of Pollution

One of the most important problems in the pollution of inland waters is the progressive enrichment of water with nutrients which leads to mass production of algae, increased productivity and other un-

desirable biotic changes (Stumm and Stumm Zollinger, 1972). Land-water interface of Lake Anasagar is rich in algal diversity and species variations are due to type of pollutant load at different interface sites (Sharma and Sharma, 1992).

During the present investigation, out of total 123 algal species belonging to 60 genera, species such as *Actinestrum hantzschii, Ankistrodesmus falcatus, Chlorella vulgaris, Chlorococcum infusionum, Pandorina morurn, Pediastrurn tetras, Scenedesmus acuminatus, S. obliquus, S. quadricauda* and *Stigeoclonium tenue* (all Chlorophyceae); *Achnanthes hungarica, Cycotella meneghiniana, Diatoma vulgare, Navicula cryptocephala, N. cuspidata, N. viridula, Nitzschia palea* and *N. recta* (all Bacillariophyceae); *Euglena acus, E. polymorpha, E. viridis* and *Phacus longicauda* (all *Euiglenineae*); *Arthospira jenneri, Chroococcus minutus, Microcystis aeruginosa, M. flosaquae, Oscillatoria chlorina, O. subbrevis, O. tenuis* and *Spirulina major* (all Cyanophyceae), were found to be pollution indicator species. A number of workers have also reported many algal species as indicator of water pollution (Patrick, 1949; Palmer, 1969; Cairns and Lanza, 1972).

Trophic State Indices

On the basis of number of algal species belonging to various groups, Nygaard (1949) has devised an index to assess the eutrophication status of lakes. Nygaard's Indices as biomonitoring is a reliable and economical means of water quality monitoring (Kohlmann *et al.*, 2018 and Pham, 2020).

Trophic indices presented in Table 1 indicate that except diatom index, all the indices show eutrophic condition of Anasagar Lake. CQ with highest value (9.11) shows hyper eutrophic condition of the water body. Sharma and Sharma in (1991) reported weak eutrophic condition of the lake.

Macrophytes

Macrophytes represent a major vegetational group in land-water interface of shallow waters and nutrient loading affects their composition in terms of both diversity and density. The aquatic vegetation of Anasagar lake comprised of only 39 species of floating (6), submerged (8), and emergent (24) *zones* (Sharma, 1993). Purohit and Singh (1985) also recorded less number of species from eutrophic lakes. Macrophytes play an important role in nutrient dynamics of an aquatic ecosystem. Not only do they absorb larger amounts of nutrients due to higher production, but several species are known to take nutrients far in excess of their growth requirements (Reddy and DeBusk, 1987).

Nutrient Release Potentials

Nutrient release through macrophyte decay is an important parameter to evaluate trophic status of water bodies characterized by low depth where total biomass productions during the peak growing period is converted into dead matter due to exposed sediment of the peripheral zone during the summer season. Anasagar Lake is also characterized by the same phenomenon and marked with seasonal changes in water level.

The total biomass production and nutrient content computed in Kg ha^{-1} yr^{-1} for various dominant

Table 1. Nygaard's Trophic State Indices of Anasagar Lake of Ajmer.

Index	Calculation	Range of index for Oligotrophic	Trophic Index Eutrophic
Cyanophycean	0.0—0.4	0.4—3.0	3.66
Chlorophycean	0.0—0.7	0.7—9.0	1.66
Diatom	0.0—0.3	0.0—1.75	0.10
Euglenophycean	0.0—0.2	0.0—1.0	0.25
Compound	0.0—1.0	1.2—2.5	1.55
Compound Quotient (CQ)	<2	>6	9.11

Table 2. Total annual biomass per ha and nutrients (kg $ha^{-1}yr^{-1}$) of dominant macrophytes at the lake Anasagar

Species	Biomass	Nitrogen	Phosphorus	Calcium	Magnesium	Total
Azolla pinnata	2970	136.5	3.80	52.28	85.26	277.99
Potamagetoncrispus	338	21.64	0.69	5.41	3.61	31.35
Trapa bispinosa	3390	88.15	5.45	108.50	97.31	299.41
Vallisneria spiralis	812	30.89	1.30	13.00	10.64	55.83

macrophytes are given in Table 2. Based on total annual biomass production per ha and total content of nitrogen, phosphorus, calcium and magnesium of individual macrophyte species, *Trapa bispinosa* and *Azolla pinnata* contributed much to the nutrient enrichment than *Potamagetoncrispus* and *Vallisneria spiralis*. Study suggests that if these macrophyte species are removed before decomposition starts, nutrient enrichment of the lake may be checked to a large extent. It was also estimated that besides other sources of nutrients, macrophytic vegetation plays a major role in releasing nutrients into the lake water and are more responsible for inducing eutrophic conditions of freshwater bodies.

Present study indicates that the Lake Anasagar has become highly eutrophic, and this condition may lead to further deterioration of this precious water body of Ajmer. Recently, Anasagar Lake has been covered under the National Lake Conservation Plan (NLCP). The main objective envisaged in this project is prevention of pollution from point source causing lake degradation and in-situ lake conservation. This will favourably affect the biological components of the water body but for improvement of water quality, pollutants coming from non-point sources of pollution like agricultural practices and cloth washing activities should also be checked in the vicinity of lake.

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